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Network Working Group
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Report of the Second Ad Hoc Network Management Review Group

Status of this Memo

This RFC reports an official Internet Activities Board (IAB) policy position on the treatment of Network Management in the Internet. This RFC presents the results and recommendations of the second Ad Hoc Network Management Review on June 12, 1989. The results of the first such meeting were reported in RFC 1052 [1]. This report was approved and its recommendations adopted by the IAB as assembled on July 11-13, 1989. Distribution of this memo is unlimited.

INTRODUCTION

On February 29, 1988, an Ad Hoc Network Management Review Group was convened to consider the state of network management technology for the Internet and to make recommendations to the Internet Activities Board as to network management policy. The outcome of that meeting was summarized in RFC 1052 and essentially established a framework in which two network management protocols now known respectively as Simple Network Management Protocol (SNMP) and Common Management Information Protocol on TCP (CMOT) were selected for further work. Subsequently, both SNMP [6] and CMOT [5] were advanced to Draft-Standard/Recommended status for use in the Internet [SNMP: RFC 1098, CMOT: RFC 1095].

Simultaneously, it was agreed to establish a working group to coordinate the definition and specification of managed objects to be used in common with either protocol. In addition, it was agreed to use the then current ISO Structure of Management Information (SMI) specification as a reference standard to guide the naming and abstraction conventions that would be followed in constructing the common Internet Management Information Base (MIB). The Internet versions of SMI and MIB were specified in RFC 1065 [2] and RFC 1066 [3] respectively.

In the intervening fifteen months, considerable progress has been made in the specification of a common Management Information Base and in the implementation, deployment and use of network management tools in the Internet.

The current public subtree of the Internet MIB contains roughly 100 variables (i.e., managed objects) agreed by the SNMP and CMOT working groups as mandatory for Internet network management. The June 12, 1989 meeting which this document reports was convened to review the progress to date, to determine whether actions were needed to foster further evolution of network management tools and to recommend specific actions in this area to the IAB.

SNMP STATUS

Immediately after the meeting reported in RFC 1052, a group was convened to make extensions and changes to the predecessor to SNMP: Simple Gateway Monitoring Protocol. A "connectathon" was held at NYSERNet, an RFC published, and demonstrations of network management tools using SNMP were offered in the Fall at Interop 88 [a conference and show presented by Advanced Computing Environments (ACE)]. The protocol is in use in a number of networks within the Internet as well as in private packet networks internationally. A number of vendor implementations are in the field (e.g., cisco Systems, Proteon, The Wollongong Group), vendor independent reference implementations (e.g., NYSERNet, Case and Key in Tennessee) along with some freely available versions (e.g., MIT, CMU).

It is important to note that while the common Internet Management Information Base has roughly 100 variables, a typical SNMP monitoring system may support anywhere from 100 to 200 ADDITIONAL objects which have been defined in private or experimental MIB space. Many of these are device or protocol dependent variables.

Scaling to include larger numbers of monitored objects and subsystems remains a challenge. It was observed that fault monitoring was easier to scale than performance and configuration monitoring, since the former may operate on an exception basis while the latter is more likely to require periodic reporting.

CMOT STATUS

RFC 1095 (CMOT) was recently published and built upon experience gained earlier with prototype implementations demonstrated at Interop 88 in the Fall of that year. The present specification for CMOT is based on the ISO Draft International Standard version of Common Management Information Protocol (CMIP). The CMIP is being moved to International Standard status, though the precise timing is not perfectly clear. It will happen late in 1989 or perhaps in the first quarter of 1990. Some changes will be made to correct known errors and the CMIP document itself will probably be restructured.

During this discussion, it was pointed out that there is much to

network management which is not addressed by either the CMOT or the SNMP specifications: for example, down loading of software, configuration management and user access control. Authentication of the source of network management commands and responses is another area important to providers and users of network management tools.

The National Institute for Standards and Technology (NIST) is sponsoring the development of implementors' agreements on the functional behavior of network management tools including, inter alia, logging, event reporting, error reporting, structured object management, and alarm reporting.

Although at the time of the meeting, there were no publicly available implementations of CMOT reported, developments were reportedly planned by a number of vendors both in the form of agents and network management tools. The University of Wisconsin plans to demonstrate CMOT using the ISODE software at Interop 89 [(tm) ACE] in September 1989.

MIB AND SMI STATUS

In the Fall of 1988, two RFCs were published (1065 and 1066) to specify the Structure of Management Information (SMI) and the initial Internet Management Information Base (MIB) respectively. There were some challenges in crafting this set of commonly agreed variables; in the end, roughly 100 were agreed and defined as mandatory for Internet management.

It was recognized in this process that the definition of the layer BELOW IP was a difficult task. IP is sufficiently simple and general that it has been moved in encapsulated form over many media including the MAC level of various local nets, X.25 packet level, serial line protocols, multiplexors, tunnels and, it is rumored, tin cans and string.

At the Transport level, specifically for TCP, it was observed that information about the transient status of connections was potentially inaccessible to the network management tools since the loss of a TCP connection typically meant loss of its Transmission Control Block (status block) just when you wanted to look back into the history of its state. Countervailing this observation was evidence that looking at TCBs with network management tools yielded far more insight into the transient behavior of TCP than looking at aggregated network statistics.

It was clear from the discussion that there is strong interest in extending the variables accessible via network management tools. Adding new devices, new higher level protocols and the ability to

manipulate configuration information were high on the list of desirable extensions, although several participants felt that this desire needed some moderation.

A vital, but unsettled research area has to do with relationships among groups of monitored variables. A particular implementation may have IP operating atop X.25. The problem is to be able to make queries about the condition of monitored variables so that those for the IP level can be correlated with those for a lower layer, for instance. This notion of relationship is especially important as network devices (including hosts) begin to sport multiple network connections and multiple protocol suites operating in parallel. Just how the dynamics of such relationships are to be specified, defined and instantiated is the research question. What sort of SMI is appropriate? What generic structure is needed for the management objects?

Another difficult topic has to do with version numbers for SMI. The issue is "which version of MIB is instantiated in this monitored system?" As consideration of extensions to the currently agreed SMI were contemplated during the last fifteen months, it became apparent that the question of versions was central.

Not far behind was the question of functionality of the underlying support protocols (SNMP and CMOT). The RFC 1052 recommendation was to tightly link the MIB/SMI, keeping only one such definition for both protocols. In theory, this plan would make it easier to move from one protocol base to another. In practice, it appears to have stifled exploration of new variable and function definitions in operating network environments. This point needs to be underscored: it is essential for the Internet community to have the freedom to explore the utility of the OSI offerings while, at the same time, having the freedom to respond to operational needs through the definition and use of new MIB variables and SMI features.

Yet another area still needing development has to do with the archiving of operational data collected by means of a network management tool. The ISO Common Management Information Service (CMIS) specifications do not treat this matter.

Finally, it was pointed out that registration of managed objects and their definitions was still an open area although the NIST has apparently made progress through its Network Management Special Interest Group (NMSIG) in planning for cataloging of defined management information objects.

APPLICATION PROGRAMMING INTERFACE (API)

It was generally agreed that the actual network management tools available to operators, rather than the specifics of the protocols supporting the tools, would be the determining factor in the effectiveness of any Internet network management system. A brief report was offered and discussion ensued on the possibility of creating a common application programming interface that could be used independent of the specific protocol (CMOT, SNMP, CMIP or proprietary) used to transport queries and commands.

It was acknowledged that the present service interfaces of both SNMP and CMIS have limitations (e.g., neither has any sense of time other than "now"; this makes it impossible to express queries for historical information, or to issue command requests of the form: Do X at device Y, beginning in 30 minutes). These limitations hinder both SNMP and CMOT from directly offering a comprehensive API for network management applications.

Although some positive sentiment was expressed for defining a kind of "super SMI" metalanguage to aid in the the definition of a general API, it was not clear whether the current crop of supporting protocols had sufficient semantic commonality to be used in this way. The matter remains open for investigation.

NIST ACTIVITIES

The Ad Hoc Review had the benefit of representatives from NIST who are active in the network management area. It was reported that the major focus at present is at layers 3 and 4 where objects are being defined in accordance with "templates" provided by ISO's SC21. IEEE 802 is also pursuing the definition of MIB objects, though not with the benefit of the same templates now in use by the NIST NMSIG. The layers above transport are just beginning to receive attention.

It was observed that the Internet SMI is not quite a subset of the ISO CMIS SMI. The Internet variable naming conventions are a little different and some functionality may vary. There was some uncertainty about the treatment of gauges in the Internet SMI and the corresponding OSI SMI. [L. Steinberg reported, subsequent to the meeting, that gauges latch and counters roll over in the OSI SMI, as they appear to do in the Internet SMI - VGC].

The general sense of this portion of the discussion was that a considerable amount of activity is underway with the sponsorship of NIST and that this work is relevant to the Internet community, particularly as the time approaches in which coexistence of the OSI protocol suite with the existing Internet protocols is the norm.

CONCLUSIONS AND RECOMMENDATIONS

The assembled attendees came to the conclusions enumerated below and recommends to the IAB that actions be taken which are consistent with these conclusions:

1. The Internet will exist in a pluralistic protocol stack environment and the need to coexist will persist.

2. Expansion of the common MIB has been impeded by an inability to agree on a common, extended SMI.

3. The Internet community must not ignore the work of other groups in the network management area, while at the same time, coping with the current operational needs of the Internet (and internet) communities.

4. Until we can gain operational experience with OSI network management tools (e.g., with CMIP on TCP or on OSI), we cannot specify a plan for coexistence with and transition to use of the OSI-based protocols in the Internet.

Therefore:

(a) We want to foster an environment for real CMOT/CMIP use.

(b) We should take action as needed to extend SNMP for operational reasons.

(c) We must preserve the utility of the first agreed common MIB (RFC 1066).

(d) We should develop, separately, experimental and enterprise MIB variables and seek opportunity for placing these in the common MIB.

(e) In a coexisting environment, we will need to access the same set of variables (e.g., in a given gateway or router) by means of more than one protocol (e.g., SNMP, CMIP/TCP, CMIP/CLNP, etc.).

It is recommended to the IAB that the network management efforts using SNMP and CMOT be allowed independently to explore new variables and potentially non-overlapping SMI definitions for the next 12 months so as to foster operational deployment and experience with these network management tools. In essence, it is recommended that the binding of SNMP and CMOT to a common MIB/SMI be relaxed for this period of exploration. Variables which are NOT supportable in common

by both protocols should be defined in the experimental or private parts of the MIB definition space. Obviously, care should be taken to achieve agreement within each respective working group on any variables added to the distinct SNMP and CMOT experimental spaces.

Specifically, the CMOT working group should extend its MIB and SMI definitions in the direction of the OSI/NIST specifications so as to bring CMOT into closer alignment with the OSI CMIS design.

During this period of experimentation, it is strongly recommended that the IAB seek opportunities to encourage the introduction of Internet elements which use the OSI protocols into the Internet environment. Such OSI-based elements offer an opportunity to obtain operational experience with monitoring and management support by way of the CMIP and CMOT protocols. It is anticipated that network management systems based on the OSI Common Management Information Service (CMIS) will be developed which use CMIP or CMOT, as appropriate, to manage various elements in the Internet.

It is also recommended that the IAB engage in an active liaison effort with the NIST, focusing especially on the question of coexistence of the Internet protocols with OSI protocols. If at all possible, joint experimental or test-bed efforts should be initiated to identify means for supporting this coexistence.

As necessary, the Internet Engineering Task Force should be directed to restructure its network management efforts both to support the need for MIB/SMI exploration by the SNMP and CMOT groups and to strengthen links between the IETF efforts and those of NIST.

Finally, it is recommended that the Ad Hoc Review Group be reconvened at 6 month intervals to review status and to determine whether opportunities for expanding the common MIB/SMI are available.

REFERENCES

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Ethernet", RFC 1089, Rensselaer Polytechnic Institute, MIT Laboratory for Computer Science, NYSERNet, Inc., and University of Tennessee at Knoxville, February 1989.

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Appendix A - Ad Hoc Net Management Review Attendance List

Amatzia Ben-Artzi	3Com
Paul Brusil	MITRE
John Burruss	Wellfleet Communications
Jeff Case	University of Tennessee at Knoxville
Vint Cerf	National Research Initiatives
Ralph Droms	Bucknell University (on sabbatical at NRI)
Mark Fedor	NYSERNet
Phill Gross	National Research Initiatives
Lee LaBarre	MITRE
Bruce Laird	Bolt Beranek and Newman
Gary Malkin	Proteon
Keith McCloghrie	Wollongong
Craig Partridge	Bolt Beranek and Newman
Marshall Rose	NYSERNet
Greg Satz	cisco Systems
Marty Schoffstall	NYSERNet
Louis Steinberg	IBM
Dan Stokesberry	NIST
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